Staff Report of the

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD

CENTRAL VALLEY REGION

REVIEW OF SELENIUM CONCENTRATIONS IN WETLAND WATER SUPPLY CHANNELS IN THE GRASSLAND WATERSHED

MAY 2000

State of California

California Environmental Protection Agency

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THIS REPORT WAS CONSIDERED AND APPROVED BY THE CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD ON 28 APRIL 2000

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Information presented is based on data collected by the Agricultural Unit of the Central Valley Regional Water Quality Control Board and information provided by the U.S. Bureau of Reclamation, Grassland Area Farmers, Central California Irrigation District, Panoche Water Drainage District, and Redfern Ranches

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EXECUTIVE SUMMARY

Selenium is a naturally occurring trace element known to be hazardous to waterfowl at elevated levels. Elevated concentrations of selenium occur in the shallow groundwater in a 97,000 acre drainage project area (DPA) contained within the Grassland Watershed in the lower San Joaquin Valley. Subsurface agricultural drainage from this area has historically commingled with water used for wetland supply while being routed for discharge into the lower San Joaquin River. In September 1996, the Grassland Bypass Project (GBP) began operation and diverted the subsurface drainage from the DPA into a single channel, removing this discharge from approximately 90 miles of wetland water supply canals. Although selenium levels in the canals decreased substantially, the 2 µg/L selenium water quality objective adopted to protect wetland habitat has been exceeded in some of the canals of concern.

In response to the selenium exceedances, Regional Board staff met with representatives from local water and drainage districts, the Grassland Area Farmers who manage the drainage from the DPA, and State and Federal agencies involved in the GBP such as the US Bureau of Reclamation, US Fish and Wildlife Service, and California Department of Fish and Game. Several potential causes of the elevated selenium concentrations were identified, including releases from the DPA (both in response to flood events and seepage from gates and canals), elevated selenium concentrations in supply water, inflows from other sources such as the Rice Drain and Almond Drive Drain, and local sources such as groundwater seepage and surface return flows.

The Grassland Drainage Area is subject to impacts from flooding from westside streams such as Panoche/Silver Creek and to impacts from storms within the drainage area. Most storm water from Panoche/Silver Creek is discharged to the San Joaquin River at the Mendota Pool. During some storm events, flow in Silver Creek, which is a dry channel for most of the year, can exceed the capacity of its channel, resulting in extensive flooding of agricultural and residential areas. These flood flows may contain elevated levels of selenium.

During 1997 and 1998, winter storm and flood flows were directed around the Grassland Bypass to protect the integrity of the Bypass itself. During these high flow events, drainage was released into wetland water supply channels historically used for drainage release. The time periods of these known releases correspond to periods of elevated selenium concentrations in the channels. However, selenium concentrations remained elevated in some water bodies after the known storm water diversions ceased.

The continuation of elevated selenium concentrations after the initial diversions was linked to: diversion of water from flooded farm land which was assumed to be of good quality and later found to contain selenium concentrations up to 20 ug/L; and periods of very low flow in Camp 13 Slough when the majority of flow was from leaks in the gates separating the slough from the main supply canal and from major drains.

The GAF have since developed a stormwater management plan to control diversion and by 21 April 1998, all inlets from the GBP drainage area to Camp 13 Slough were plugged (GAF memo, 27 August 1998).

The major source of supply water to the DPA and the Grassland Watershed overall is the Delta Mendota Canal (DMC) via the Mendota Pool and the Central California Irrigation District (CCID) Main Canal. Selenium concentrations in the DMC, Mendota Pool and Main Canal have exceeded
2 µg/L on a number of occasions, primarily during storm events. Potential sources of selenium in the DMC include: discharge from six shallow groundwater collection systems operated by the USBR as interceptor drains along the DMC and flood flows through existing check drains.

Potential sources of selenium into the Mendota Pool is the subject of a separate study being conducted by the Regional Board's Fresno Office. Some sources identified include the shallow groundwater pumped directly into the DMC from the six collector systems described above, groundwater pumping into the Mendota Pool, and flood flow and sediment loading during flood events in the Panoche and Silver Creek watershed.

Two areas have been identified where agricultural subsurface drainage can enter wetland water supply canals from farmland not contained in the DPA. One area is west of the wetland water supply channels and historically drained into the Almond Drive Drain which entered South Grassland Water District at Almond Drive. A second area is a triangle-shaped area of approximately 7,000 acres south of the Poso Drain (also known as the Rice Drain) and north of the DPA which historically drained into the Poso Drain which enters South GWD from the east.

Drainage from the Almond Drive Drain area can impact the San Luis Canal in two ways: direct discharge to the Canal; and discharge to the CCID Main Canal, which is the source of water delivered to the San Luis Canal. In June 1998, a pump was installed on the Old Main Drain, to allow the drain water to be diverted directly into the CCID Main Canal downstream of the diversion to the San Luis Canal. A pump just north of Almond Drive was reactivated in June 1998 to allow drainage to be pumped into the CCID Main Canal when water threatened to enter the San Luis Canal directly through the drop structure. The Almond Drive pump allows drainage to be commingled with supply water upstream of the San Luis Canal diversion. The new plumbing system is expected to remain in place.

The Poso Drain (listed as the Rice Drain on US Geological Survey quads) has consistently exceeded the 2 µg/L selenium water quality objective to protect wetland supply water since March 1998. The area farmers are aware of the exceedances in the Rice Drain and have been reviewing the discharges to determine potential selenium sources and options to remove the selenium from the water body. Upon startup of the Grassland Bypass Project, discharges from two systems were redirected into the Grassland Bypass. Additional discharges will either be redirected to the San Luis Drain along the east side of Russell Avenue or will be managed on farm.

The Grassland Area Farmers have developed a storm event plan (GAF, 1997) in an attempt to deal with the immediate threat of exceeding the capacity of the Grassland Bypass channel and to track the stormwater and resulting water quality should rerouting of the discharge be necessary.

Other potential sources of selenium into wetland water supply channels include tail water (surface water) runoff from irrigation and local groundwater seepage. To date, little information is available on these potential sources. Until the major sources of selenium have been controlled, determining impacts from irrigation tailwater and subsurface seepage in addition to general background concentrations will be difficult to evaluate.

To continue to evaluate the effectiveness of current control measures and guide future efforts, the following activities are anticipated:

- Continue monitoring of CCID Main Canal and other supply water on a regular basis;
- Conduct additional special studies on an as-needed basis;
- Focus on reducing selenium from the following sources:
  --source water;
  --subsurface drainage from outside of the DPA;
- Re-evaluate situation to see if additional work is needed to identify and/or control additional sources.

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INTRODUCTION

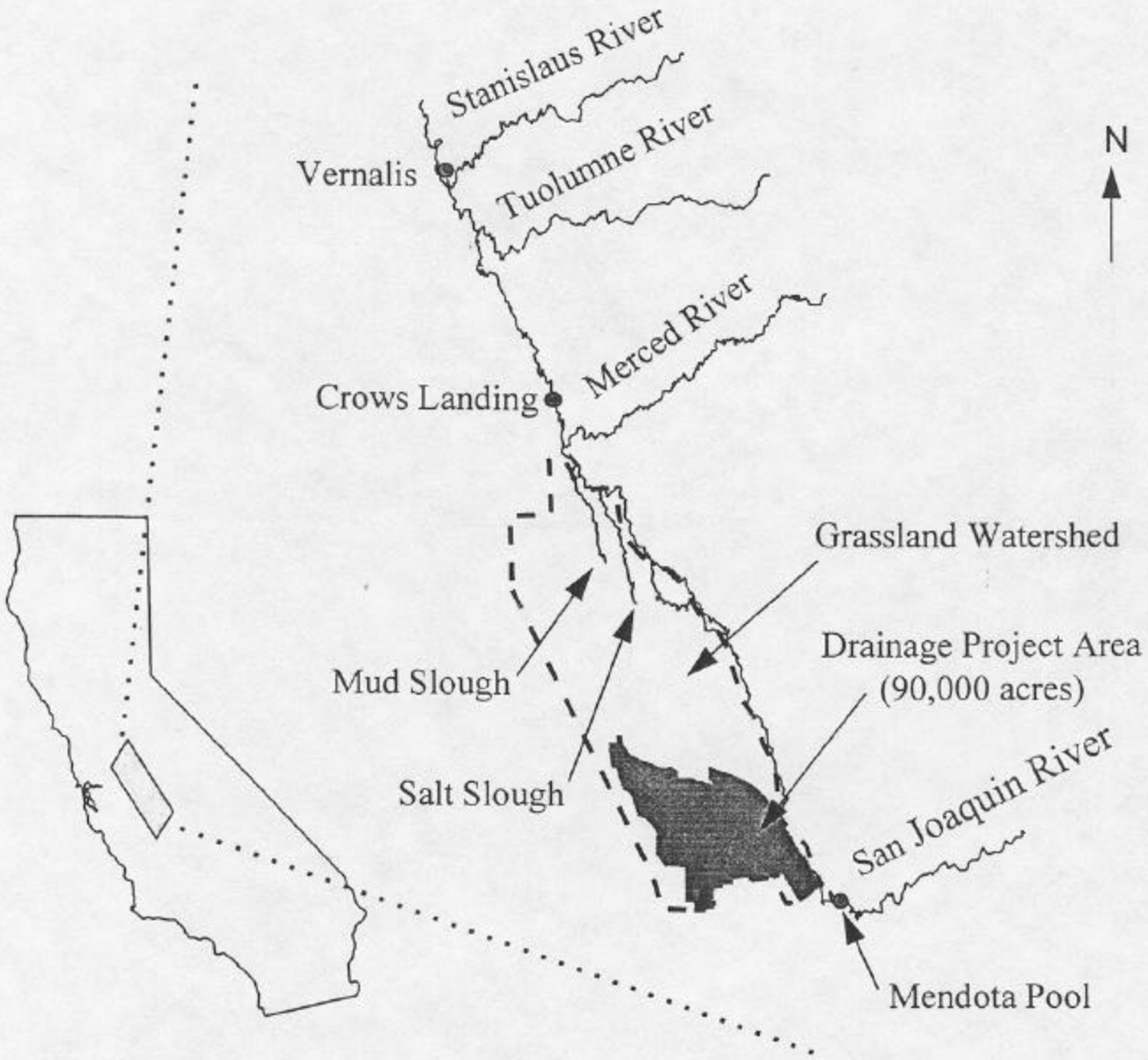
Selenium is a naturally occurring trace element known to be hazardous to waterfowl at elevated levels. Elevated concentrations of selenium occur in the shallow groundwater in a 97,000 acre drainage project area (DPA) contained within the Grassland Watershed in the lower San Joaquin Valley. Subsurface agricultural drainage from this area has historically commingled with water used for wetland supply while being routed for discharge into the lower San Joaquin River. In September 1996, the Grassland Bypass Project began operation and diverted the subsurface drainage from the DPA into a single channel, removing this discharge from approximately 90 miles of wetland water supply canals. Although selenium levels in the canals decreased substantially, the 2 µg/L selenium water quality objective adopted to protect wetland habitat has been exceeded in some of the canals of concern. A review of potential causes for the exceedances has been conducted and concurrently, a number of steps have been taken to reduce selenium discharges to wetland channels. This report presents the preliminary findings.

BACKGROUND

The Grassland Watershed is located west of the San Joaquin River between the towns of Newman and Mendota, in the San Joaquin River Basin in California. The watershed encompasses approximately 370,000 acres and includes the northern and southern divisions of Grassland Water District (GWD), and farmlands adjacent to the district. The watershed also contains a 97,000 acre area known as the Drainage Project Area (DPA) and approximately 100,000 acres of wetland habitat, including State and Federal wildlife refuges and private gun clubs (Figure 1). The DPA has a perched shallow groundwater table containing high levels of dissolved salts and selenium.

Prior to September 1996, agricultural lands east, west, and south of the GWD discharged subsurface agricultural drainage water and surface runoff (irrigation tailwater) through the GWD. Subsurface drainage from this area often contains high concentrations of salt, selenium and other trace elements. This regional drainage flowed north through the GWD, carried by a network of

Figure 1. The Grassland Watershed Within the Lower San Joaquin River Basin.



canals that could route the water in several possible ways before discharging it into Mud Slough (north) or Salt Slough. These two sloughs are tributary to the San Joaquin River and serve as the primary drainage outlets for the Grassland Watershed.

On 26 September 1996, the Grassland Bypass Project (GBP) began operation. The GBP consolidated the subsurface drainage from the DPA into a single channel, the Grassland Bypass Channel, which discharges into the San Luis Drain. The San Luis Drain then discharges into Mud Slough (north), nine miles upstream of its confluence with the lower San Joaquin River. Consolidating the subsurface drainage removed the drainage from the DPA from approximately 90 miles of canals which can supply water to wetland habitat. Reducing selenium in these water bodies is a primary goal of the project, since elevated concentrations of selenium have been documented to be hazardous to waterfowl (Skorupa, 1998). In May 1996, the Central Valley Regional Water Quality Control Board adopted a 2 µg/L (monthly average) selenium water quality objective for the wetland water supply channels to protect waterfowl. This objective became effective on 10 January 1997 upon final approval by the Office of Administrative Law.

A water quality monitoring program has been conducted in the Grassland Watershed and Lower San Joaquin River since 1985, to evaluate impacts of agricultural drainage on downstream water bodies (Steensen et al., 1998). After the GBP began operation, the program was altered to reflect the changes in drainage water management. Key sites which were maintained and provide comparison to pre-bypass conditions included: Camp 13 Slough and Agatha Canal (major supply canals for wetlands within GWD); Santa Fe and San Luis Canals at Henry Miller Road (internal distribution channels for wetland habitat); and Mud Slough (north) and Salt Slough (outflow from the watershed). Water quality monitoring conducted both prior to and after the GBP began operation indicated that although overall selenium concentrations in the wetland water supply channels decreased dramatically after the GBP was operational, some channels continued to exceed 2 µg/L selenium on a sporadic basis (Chilcott et al., 1998). In particular, since October 1996, selenium concentrations in the San Luis Canal and Santa Fe Canal, two internal distribution canals for wetland habitat, exceeded 2 µg/L selenium almost continuously during winter storm events and occasionally throughout the remainder of the year. Selenium

concentrations in Camp 13 Slough and Agatha Canal, exceeded 2 µg/L less frequently than the internal distribution canals, with elevated concentrations primarily linked to storm events.

In response to the initial findings, Regional Board staff met with representatives from local water and drainage districts, the Grassland Area Farmers who manage the drainage from the DPA, and State and Federal agencies involved in the GBP such as the US Bureau of Reclamation, US Fish and Wildlife Service, and California Department of Fish and Game. Several potential causes of the elevated selenium concentrations were identified, including releases from the DPA (both in response to flood events and seepage from gates and canals), elevated selenium concentrations in supply water, inflows from other sources such as the Rice Drain and Almond Drive Drain, and local sources such as groundwater seepage and surface return flows. The monitoring program was reevaluated and the following additional sites incorporated: the Central California Irrigation District Main Canal to document selenium in supply water; the Almond Drive Drain and Rice Drain to evaluate drainage from lands northwest and northeast of the DPA, respectively; and two additional upstream sites on the Santa Fe and San Luis Canals to further evaluate internal distribution. This report summarize information available on releases from the DPA and selenium in supply water, and documents preliminary results from a special study conducted to determine potential inputs from the Almond Drive Drain and Rice Drain.

RELEASES FROM THE DRAINAGE PROJECT AREA (DPA)

Summary reports by the US Bureau of Reclamation (USBR, 1997) and Grassland Area Farmers (GAF, 1998) identified times during 1997 and 1998, respectively, when winter storm and flood flows were directed around the Grassland Bypass to protect the integrity of the Bypass itself. During these high flow events, drainage was released through Camp 13 Slough and the Agatha Canal into channels historically used for drainage release. During 1997, these releases occurred between 27 January and 5 February. During 1998, the duration of releases increased from 3 February 1998 to 28 February 1998, in response to continued flood flows and elevated water levels from major storm events. The time periods of these known releases correspond to periods of elevated selenium concentrations in the San Luis and Santa Fe Canals. However, selenium

concentrations remained elevated in these water bodies after the known storm water diversions ceased.

During March and early April, 1997, elevated selenium concentrations were noted at Camp 13 Slough. Regional Board staff observation and discussion with GWD staff confirmed that water from the Main Drain, which contained drainage from adjacent flooded farm land, was being diverted into Camp 13 Slough during this time period. This water was not from farmland participating in the GBP and staff from the water district assumed that the flood water was of good quality. Review of data collected using an automated sampler which was in place at Camp 13 Slough until 25 March 1997, indicated that the diverted water contained levels of selenium that peaked at 21.2 µg/L. Diversion of the ponded water ceased on 28 March 1997. Additional periods of elevated concentrations also occurred between April and September 1997. These elevated concentration corresponded to a period of very low flow in Camp 13 Slough. Little, if any, supply water was being delivered and the majority of flow was from leaks in the gates separating the slough from the main supply canal and from major drains. Reports from the San Luis and Delta-Mendota Water Authority (SLDMWA, 1997) indicate that between 5 and 10 gpm will leak from the Main Drain into Camp 13 Slough through the closed gates.

Wet weather during 1998, delayed needed improvements in the Camp 13 Slough area to insure that drainage would not seep into supply canals. Selenium concentrations in Camp 13 Slough and Agatha Canal remained above 2 µg/L even after direct diversion of flood related drainage ceased on 28 February 1998. However, by 21 April 1998, all inlets from the GBP drainage area to Camp 13 Slough were plugged as follows (GAF memo, 27 August 1998)(Figures 2 and 3):

- Hamburg (Pacheco) Outlet was sealed at the gate on the south side of the Outside Canal and a dirt dam installed at the old Pacheco Meter location;
- A dam was installed in the Main Drain east of any inlets to Camp 13 Slough to prevent any seepage into Camp 13 Slough; and
- A slide gate was installed in the Camp 13-SW field drain. This slide gate will only be opened when tailwater is discharged under the assumption that the quality will be less

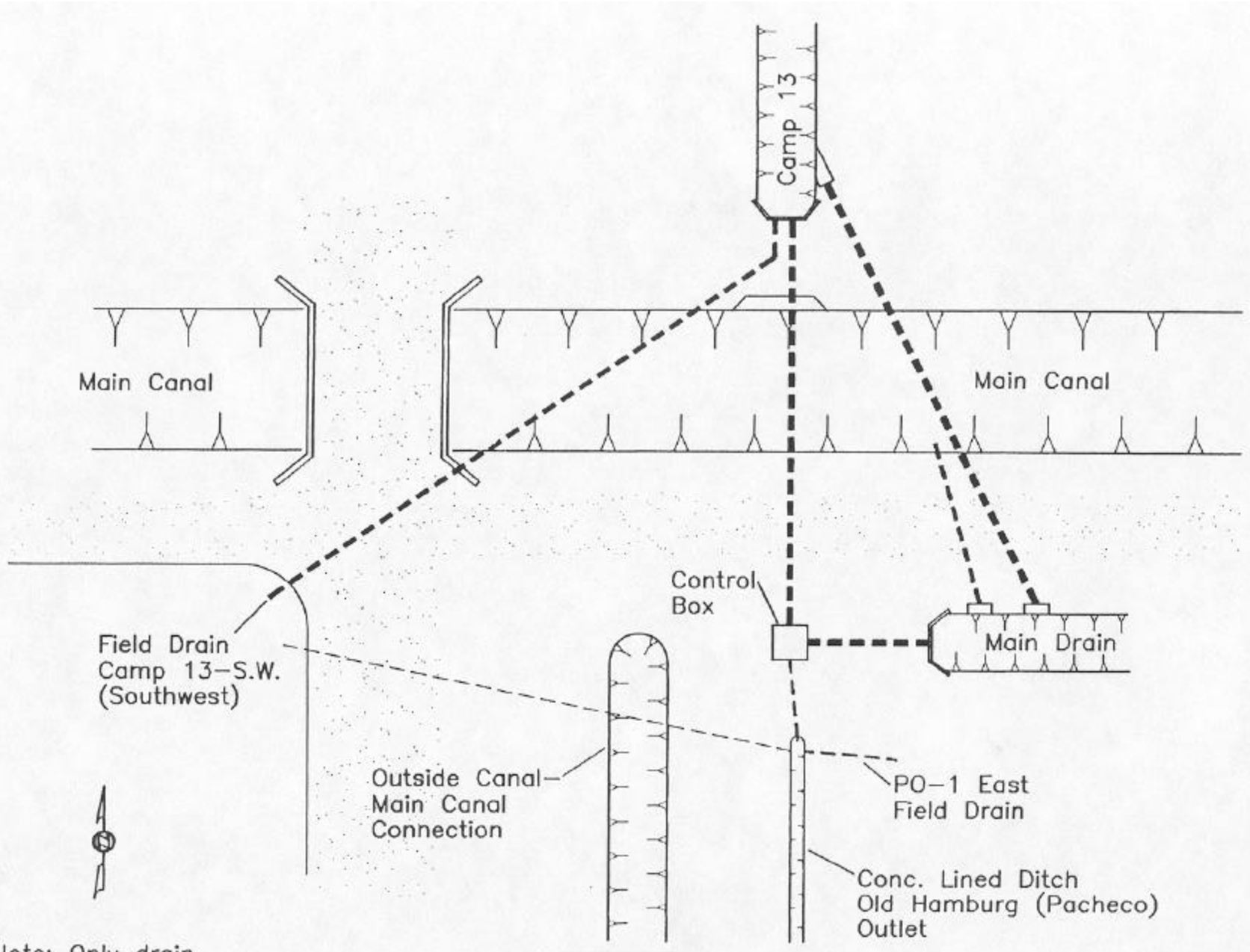
than 2 µg/L selenium. This location is outside of the official GBP drainage area and the effort was made to eliminate as many discharges as possible.

Some minor seepage (a few gallons per minute) from the Old Hamburg (Pacheco) concrete lined ditch still occurs. This drainage in not originating within the DPA.

SUPPLY WATER

The major source of supply water to the DPA and the Grassland Watershed overall is the Delta Mendota Canal via the Mendota Pool and the Central California Irrigation District (CCID) Main Canal. All available selenium water quality data for these water bodies since October 1996, has been listed in Table 1. Selenium concentrations in the Delta Mendota Canal, Mendota Pool and Main Canal have exceeded 2 µg/L on a number of occasions, primarily during storm events.

Two sites have been monitored monthly on the Delta Mendota Canal (DMC) by the U.S. Bureau of Reclamation (USBR) since March 1985. The first site is at milepost 100.85 and represents water quality upstream of the discharge of six shallow groundwater collection systems operated by the USBR as interceptor drains along the DMC. The second site is at milepost 110.12 and represents the water quality downstream of the drainage inflow. Selenium concentrations reported for these sites since October 1996 are included in Table 1. Selenium concentrations downstream of the drainage inflows tend to be elevated above upstream concentrations. In addition, concentrations at both sites exceeded 2 µg/L in December 1997 and every month monitored since February 1998. In December 1997, the Mendota Pool was dewatered to allow maintenance of the facility. During the maintenance operations, water in the DMC was held stagnant. Selenium levels ranged from 9.7 to 21 µg/L at the two sites monitored in the DMC during December 1997. At the end of the maintenance activities in the Mendota Pool, water held in the DMC was released to the Pool. Selenium concentrations in the DMC at both sites monitored dropped to less than 2 µg/L by January 1998, but exceeded 20 µg/L during February 1998. The sharp spike in concentration is likely due to the February storm events and flood flows entering the DMC through existing check drains (Pierson et al., 1987). Selenium



Note: Only drain connections shown for clarity.

Figure 2

Camp 13 Location Map

SUMMERS ENGINEERING, INC.
Consulting Engineers
HANFORD CALIFORNIA
MARCH 1998

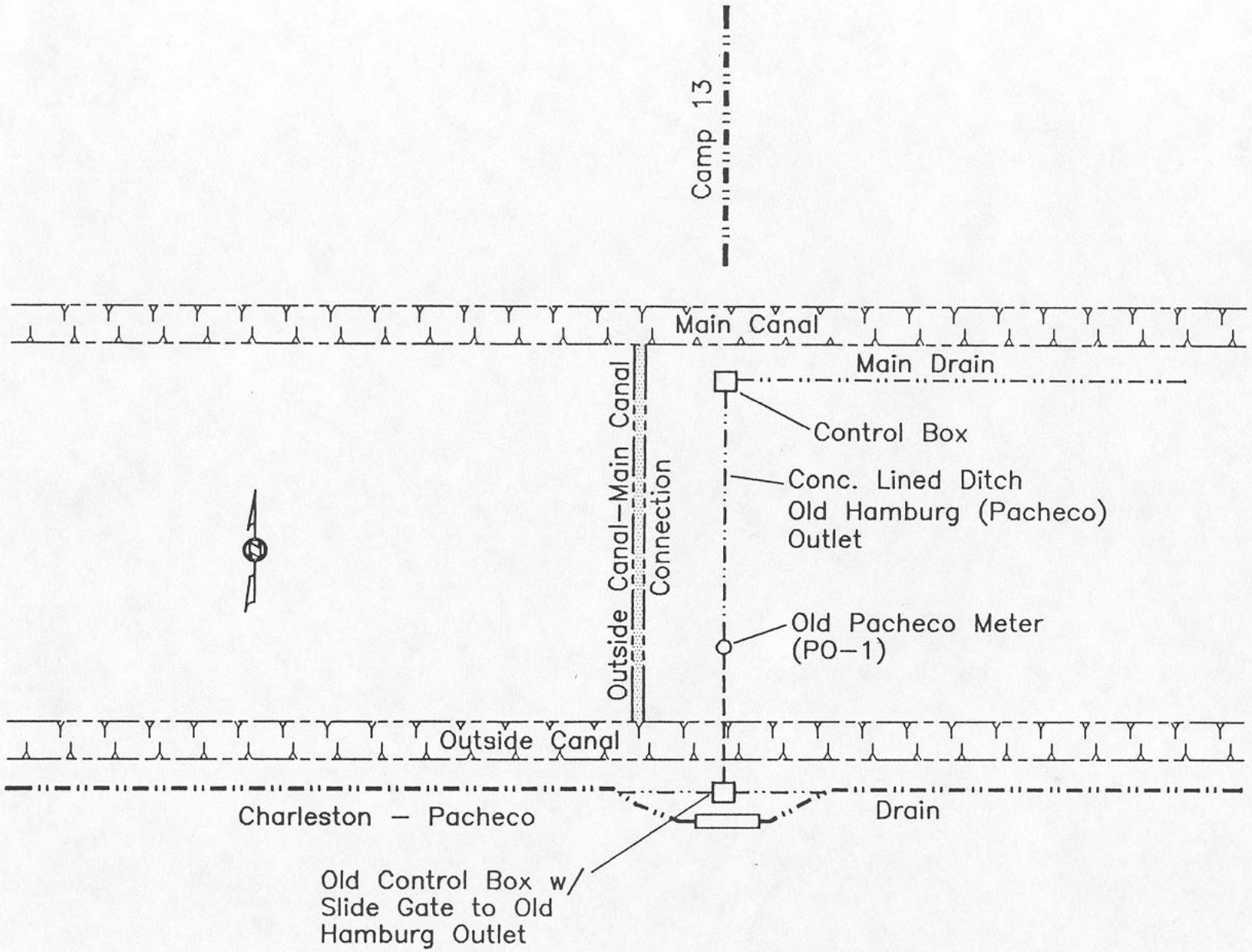


Figure 3

Old Pacheco Connection
Location Map

SUMMERS ENGINEERING, INC.
Consulting Engineers
HANFORD CALIFORNIA
MARCH 1998

Table 1. Selenium Concentrations in Supply Water for the Grassland Watershed: October 1996 through September 1998

	Selenium Concentration (µg/L)				
Date	Delta Mendota Canal MP100.85	Delta Mendota Canal MP 110.12	Mendota Pool at Mowry Bridge	CCID Main Canal @ Russell Ave.	CCID Main Canal @ Head of San Luis Canal
10/2/96	1	<1	––	––	––
10/14/96	––	––	<2	––	––
11/1/96	––	––	––	0.7	
11/13/96	<1	<1	––	––	––
11/15/96	––	––	2.9	––	––
12/18/96	––	––	2.4	––	––
1/8/97	<2	3.2	––	––	––
1/15/97	––	––	<2	––	<2
2/5/97	7	18	––	––	
2/11/97	––	18	––	––	––
2/18/97	––	––	<2	––	––
3/5/97	<2	13	––	––	
3/12/97	––	13	––	––	––
3/13/97	––	––	<2	––	––
4/2/97	––	2	––	––	––
4/10/97	<2	2.3	––	––	
4/16/97	––	––	4	––	––
5/9/97	<2	<2	––	––	––
5/15/97	––	––	4.8	––	––
6/6/97	<2	<2	––	––	
6/13/97	––	<2	––	––	––
7/9/97	<2	<2	––	––	––
7/11/97	––	––	2.2	––	4
8/14/97	<2	<2	––	––	––
9/16/97	<2	3.8	––	––	––
10/8/97	<2	<2	––	––	––
11/12/97	<2	2.1	––	––	––
12/16/97	10	21	––	––	––
1/13/98	<2	<2	––	––	––
2/4/98	––	––	––	3.1	––
2/11/98	––	––	––	3.6	––
2/18/98	––	––	––	2.8	––
2/19/98	27	24	––	––	––
2/25/98	––	––	––	2.8	––
3/4/98	8.9	24	––	3.9	––
3/11/98	––	––	––	2.4	––
3/18/98	––	––	––	1.4	––
3/25/98	––	––	––	1.5	––
4/1/98	––	––	––	3.6	––
4/2/98	3.1	7.5	––	––	––
4/8/98	––	––	––	3.4	––
4/15/98	––	––	––	2.2	––
4/22/98	––	––	––	1.1	––
4/29/98	––	––	––	1	––
5/5/98	2.8	11	––	––	––
5/6/98	––	––	––	1.3	––
5/13/98	––	––	––	0.8	––
5/20/98	––	––	––	0.6	––
5/27/98	––	––	––	0.6	––
6/3/98	2.6	5.2	––	0.7	––
6/10/98	––	––	––	0.6	––
6/17/98	––	––	––	1.1	––
6/24/98	––	––	––	1.1	––
7/1/98	––	––	––	<0.4	––
7/8/98	––	––	––	<0.4	––
7/15/98	––	––	––	<0.4	––
7/22/98	––	––	––	0.9	––
7/29/98	––	––	––	0.8	––
8/5/98	––	––	––	1.2	––
8/12/98	––	––	––	0.9	––
8/26/98	––	––	––	0.8	––
9/2/98	––	––	––	1.1	––
9/9/98	––	––	––	0.9	––
9/16/98	––	––	––	1.2	––
9/23/98	––	––	––	1.7	––
9/30/98	––	––	––	1.3	––

* = Data provided by Summers Engineering, US Bureau of Reclamation, and the Central California Irrigation District based on internal monitoring and sampling conducted by the U.S. Bureau of Reclamation.

concentrations remained above 2 µg/L in the DMC through June 1998, the last available water quality result.

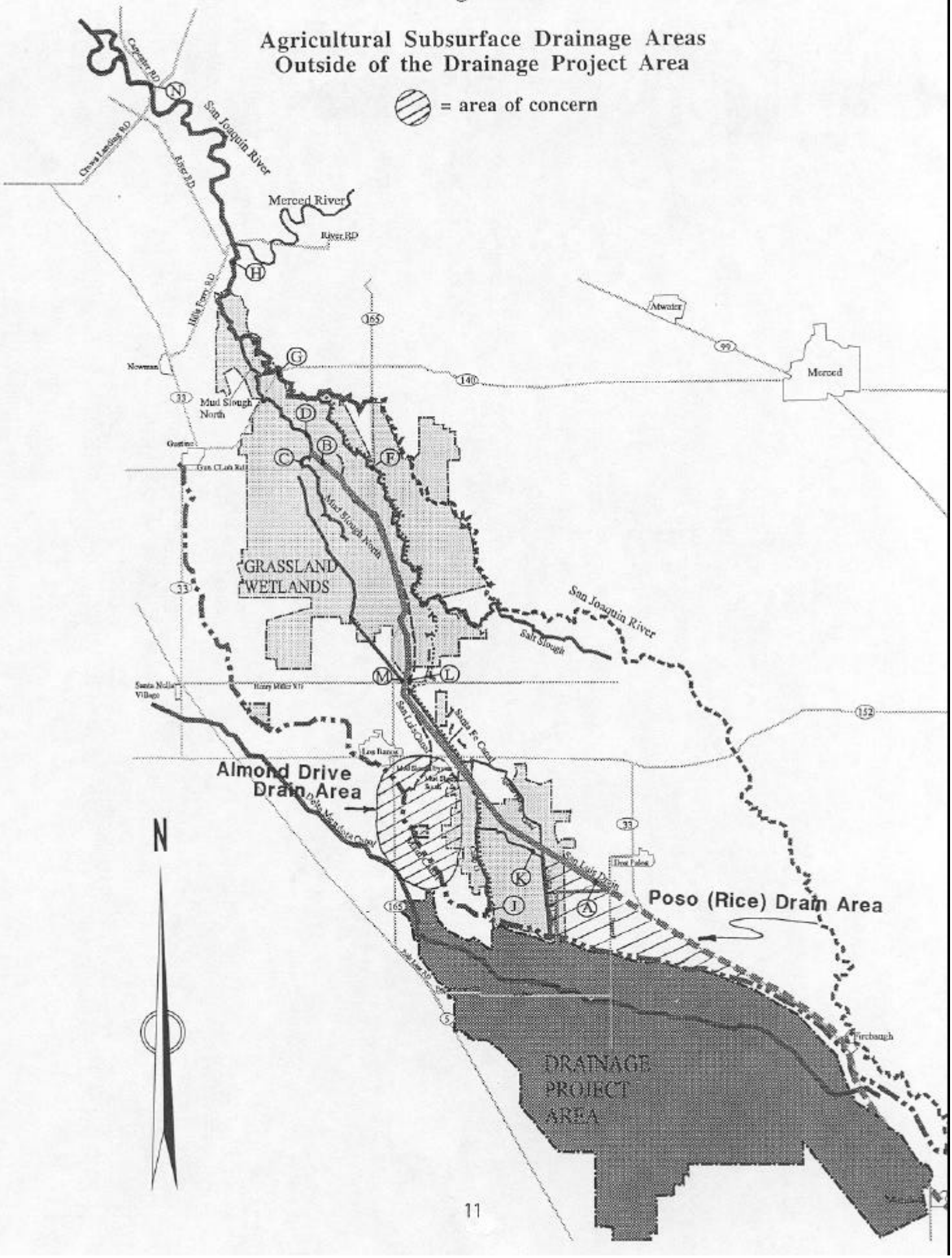
The Mendota Pool has contained selenium concentrations greater that 2 µg/L for extended periods, although the concentrations frequently decrease to below 2 µg/L downstream in the Main Canal. Evaluation of sources of selenium in the Mendota Pool is the subject of a separate study being conducted by the Regional Board's Fresno Office (A. Toto, personal communication). Some sources identified include the shallow groundwater pumped directly into the DMC from the six collector systems described above, groundwater pumping into the Mendota Pool, and flood flow and sediment loading during flood events in the Panoche and Silver Creek watershed.

SELENIUM INFLOWS FROM SOURCES OTHER THAN THE DPA

AGRICULTURAL SUBSURFACE DRAINAGE

Agricultural subsurface drainage can enter wetland water supply canals from farmland not contained in the DPA. One area is west of the wetland water supply channels and historically drained into the Almond Drive Drain which entered South Grassland Water District at Almond Drive. A second area is a triangle-shaped area of approximately 7,000 acres south of the Poso Drain (also known as the Rice Drain) and north of the DPA which historically drained into the Poso Drain which enters South GWD from the east (Figure 4). Current drainage patterns in these areas were investigated with the help of local water district personnel and water quality samples for electrical conductivity, selenium and boron from both open drains and accessible subsurface systems were collected. Findings are presented below.

Figure 4


Agricultural Subsurface Drainage Areas
Outside of the Drainage Project Area
= area of concern
San Joaquin River
Merced River
Mud Slough North
GRASSLAND WETLANDS
Almond Drive Drain Area
Poso (Rice) Drain Area
DRAINAGE PROJECT AREA
Merced
Atwater
Newman
Gustine
Firebaugh
N

Almond Drive Drain Area

Drainage from the Almond Drive Drain area can impact the San Luis Canal in two ways: direct discharge to the Canal; and discharge to the CCID Main Canal, which is the source of water delivered to the San Luis Canal.

The Old Main Drain is located to the north of the DPA and just west and parallel to the CCID Main Canal. A siphon approximately one half mile south of the drain's intersection with Mercy Springs Road allows water from this drain to flow under the Main Canal and directly into the headgates of the San Luis Canal. Historically, water from the Old Main Drain, which flowed naturally north and east of Almond Drive, was diverted under the CCID Main Canal and into the South Grassland Water District via the Almond Drain. After 1997, water was no longer diverted into the Almond Drain in response to boron and salinity concerns expressed by the South Grassland Water District, resulting in direct discharge of the drainage into the San Luis Canal. In June 1998, a pump was installed on the Old Main Drain, 3/4 miles north of Cotton Road. This pump allows the drain water to be diverted directly into the CCID Main Canal downstream of the diversion to the San Luis Canal. Two additional pumps exist along the Old Main Drain between Almond Drive and Cotton Road. These two pumps had been shut down in September 1992; however, the pump just north of Almond Drive was reactivated in June 1998 to allow additional drainage to be pumped into the CCID Main Canal when water threatened to enter the San Luis Canal directly through the drop structure. The Almond Drive pump allows drainage to be commingled with supply water upstream of the San Luis Canal diversion. The new plumbing system is expected to remain in place (Figure 5).

Water samples collected in April 1998 indicated that flow from the drop structure contained 7 µg/L selenium. Selenium concentrations downstream in the San Luis Canal exceeded the 2 µg/L selenium water quality objective (Table 2). Further review of land management in the area indicated possible subsurface agricultural drainage from seven separate areas into the Almond Drain and two additional areas directly into the San Luis Canal (Figure 6).

Figure 5. Routing of Agricultural Drainage in the Almond Drive Drain Area

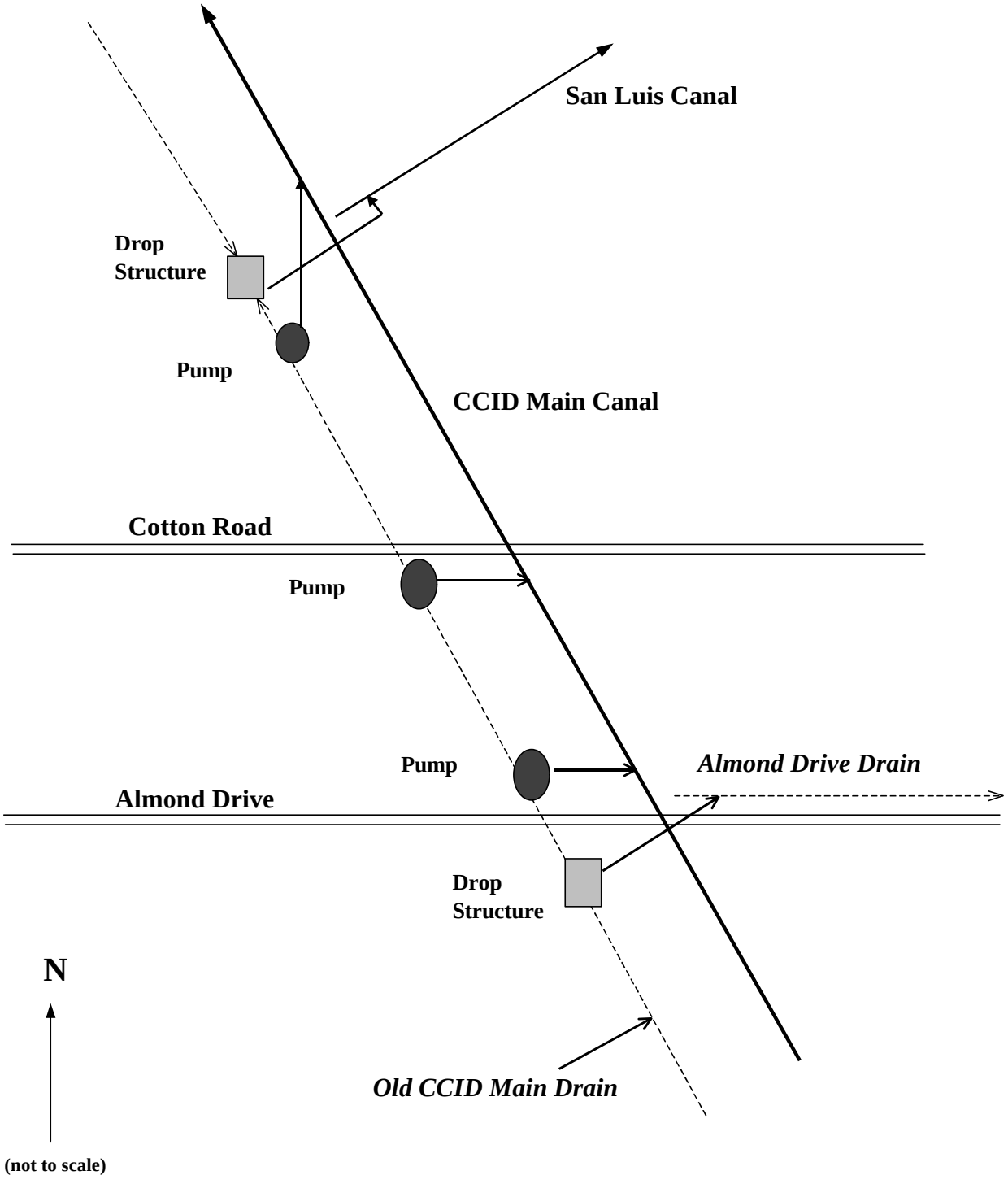


Table 2. Selenium Concentrations in Wetland Supply Channels in the Grassland Watershed: October 1996 through September 1998

	Selenium Concentration (µg/L)										
			Almond Drain					SFC @	SLC @	SFC nr	SLC @
Date	CCID Main	Rice Drain	drop structure	inflow to CCID[1]	inflow to CCID[2]	Camp 13	Agatha	Henry Miller	Henry Miller	Weir	Splits
10/1/97						1.0	0.9	2.0	1.9		
10/8/97						1.1	0.8	1.3	1.7		
10/15/97						1.0	0.7	1.6	**2.1**		
10/22/97						0.8	0.8	1.3	2.0		
10/29/97						0.8	1.0	1.1	1.1		
11/5/97						0.8	0.7	0.9	0.8		
11/12/97						0.7	0.9	1.1	1.1		
11/19/97						1.6	1.8	1.1	1.4		
11/25/97						1.6	1.7	1.1	2.0		
12/3/97						**8.4**	1.9	**2.9**	**7.2**		
12/10/97						**5.2**	0.9	1.2	2.0		
12/17/97						**8.9**	1.5	1.1	1.3		
12/23/97						1.6	0.9	1.4	1.4		
12/30/97						0.8	**5.9**	1.3	1.2		
1/7/98						1.0	0.7	1.0	1.0		
1/14/98						1.2	1.2	1.4	1.8		
1/21/98						1.7	1.6	0.9	1.4		
1/28/98						1.6	1.5	1.3	1.5		
2/4/98	**3.1**					**2.8**	**27.0**	**7.3**	**5.1**		
2/11/98	**3.6**					**4.0**	**39.2**	**13.0**	**8.3**		
2/18/98	**2.8**					**3.3**	**36.4**	**11.6**	**8.9**		
2/25/98	**2.8**					1.8	**40.4**	**8.0**	**10.5**		
3/4/98	**3.9**					**3.4**	**3.5**	**3.6**	**4.0**		
3/11/98	**2.4**					**4.0**	**3.9**	**5.4**	**5.4**		
3/18/98	1.4	***16***				**3.5**	1.1	**4.1**	**4.3**		
3/25/98	1.5	***9***				1.7	1.5	**2.8**	**3.0**		
4/1/98	**3.6**	***21***				**11.5**	**2.8**	**3.3**	**3.2**		
4/8/98	**3.4**	***22(22)***				**9.8**	1.8	**3.4**	**3.3**		
4/15/98	**2.2**	***25***	**7.1**			**7.3**	**2.2**	**3.1**	**3.4**		
4/22/98	1.1	***27***				1.7	**2.3**	1.8	1.8		
4/29/98	1.0	***12***				1.1	1.9	1.7	1.4		
5/6/98	1.3	***9***				1.6	1.4	1.6	1.8		
5/13/98	0.8	—				1.6	1.0	1.5	2.0		
5/20/98	0.6	***28***				1.3	0.9	1.9	1.5		
5/27/98	0.6	***24***				0.8	1.0	2.0	1.6		
5/28/98	1.0	—									
6/3/98	0.7	***14***				1.7	0.7	1.2	1.5		
6/10/98	0.6	***8***				**2.5**	0.7	1.0	1.5		
6/17/98	1.1	***6***				1.8	0.6	1.2	1.4		
6/24/98	1.1	—				1.0	0.6	1.2	1.6		
7/1/98	<0.4	—				0.7	0.3	1.7	1.1		
7/8/98	<0.4	***7***				0.3	0.3	0.7	1.6		
7/15/98	<0.4	**5.0(4.9)** ***3***	**2.8(2.8)**			0.3	0.2	1.1	1.6		
7/22/98	0.9	**7.0** ***(0)***	**2.7(2.6)**			**2.6**	0.4	1.5	**2.6**		
7/29/98	0.8	**4.2** ***(4)***	**3.6(4.0)**	**4.1**		1.0	1.5	1.9	**2.5**		
8/5/98	1.2	**5.9** ***(6)***	**2.8(2.8)**	**3.0**		1.3	1.4	**2.1**	**2.2**		
8/12/98	0.9	**5.3** ***(5)***	**2.8**	**2.8**		2.0	1.3	1.6	2.0	2.3	1.6
8/19/98	1.0	**3.6** ***(6)***	1.7	**5.0**	no flow	**2.1**	1.1	1.8	**3.0**	1.7	3.3
8/26/98	0.8	**4.2** ***(6)***	**2.1**	**4.2**	**4.4**	1.3	1.2	1.4	1.8	2.5	1.5
9/2/98	1.1	***6***				1.1	1.2	1.8	1.5	2.6	—
9/9/98	0.9	***7***				1.5	1.5	1.7	1.9	2.7	—
9/16/98	1.2	***6***				1.0	1.1	1.2	1.2	1.2	—
9/23/98	1.7	***3***				1.1	1.5	1.6	1.4	1.2	1.6
9/30/98	1.3					0.7	0.7	1.1	1.1	1.1	1.0

Majority of analyses conducted by SDSU

Bold indicates concentrations exceeding 2 µg/L

italics indicate preliminary data (analyzed by BSK) which is subject to change

( ) = duplicate analyses

[1] near Cotton Road

[2] near Almond Road

SFC = Santa Fe Canal

SLC = San Luis Canal

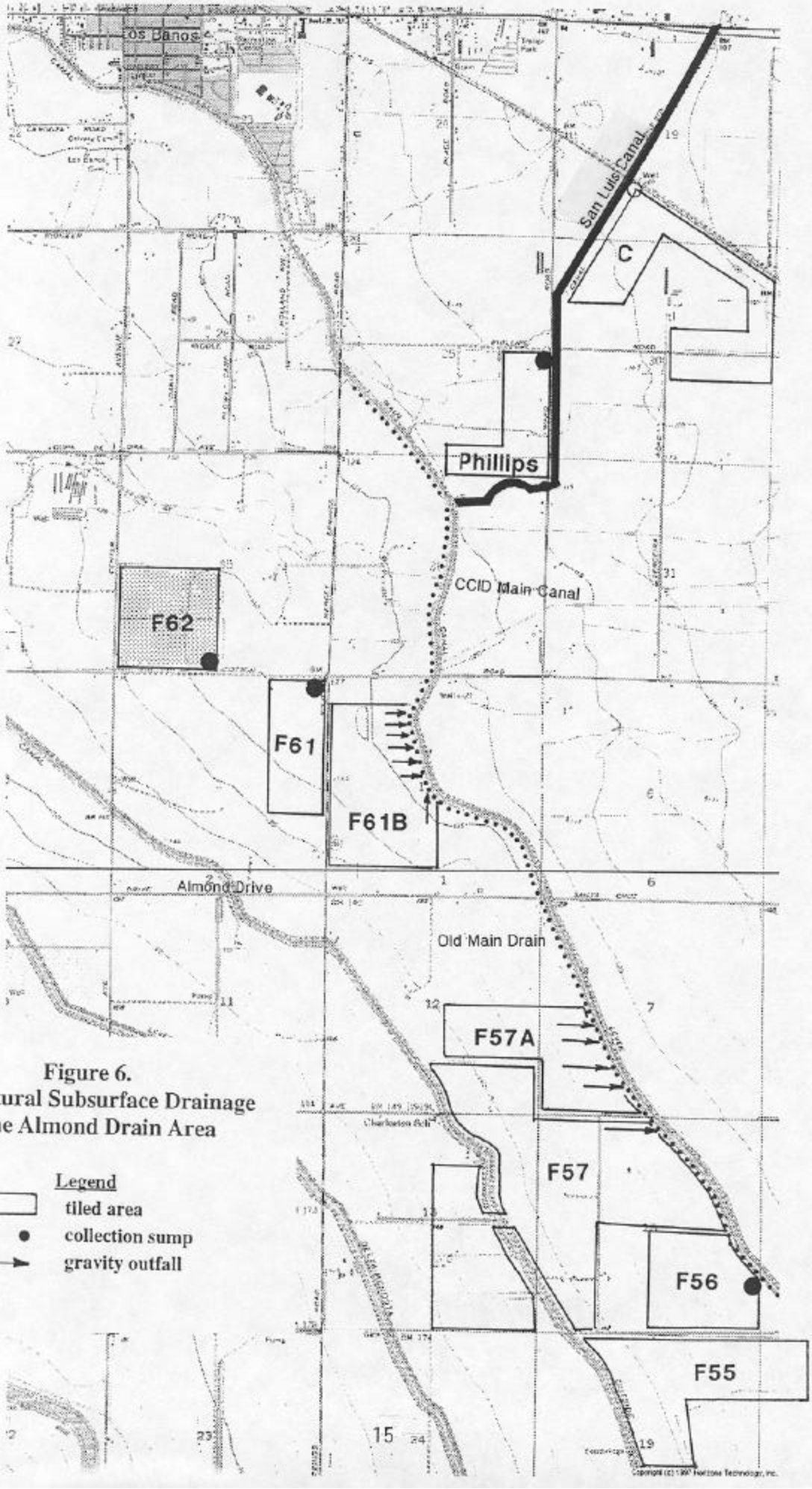


Figure 6.
Agricultural Subsurface Drainage in the Almond Drain Area

On 28 October 1998, Regional Board staff met with staff from CCID to discuss the rerouting of the Almond Drain, potential subsurface drainage inflows and the best locations to collect water samples from the subsurface systems. Water quality samples for boron and electrical conductivity have been collected by CCID staff on the 15th of each month since rerouting of the Old Main Drain and canal water took effect. Selenium was only analyzed on a quarterly basis until August 1998, when the frequency was increased to monthly.

Most of the tile systems of concern are gravity lines which drain into the Old Main Drain which runs parallel to the CCID Main Canal on the west side. Two of the systems along the San Luis Canal may drain into the canal itself, however, access was not available to the larger system that drains north of Phillips Road and east of Ward Avenue. Results of the field sampling and comments are listed in Table 3.

Poso (Rice) Drain Area

The Poso Drain (listed as the Rice Drain on US Geological Survey quads) has consistently exceeded the 2 µg/L selenium water quality objective to protect wetland supply water since March 1998. Review of surrounding land use indicated ten separate areas which may contribute subsurface agricultural drainage to this drain. To further complicate water flow, both the San Luis Drain and the Grassland Bypass also transect the area (Figure 7). On 29 October 1998, Regional Board staff met with staff from Panoche Water District and Redfern Ranches, to discuss the water quality objective exceedances, plumbing of the subsurface drained areas, and water quality of the subsurface discharges.

The area farmers are aware of the exceedances in the Rice Drain and have been reviewing the discharges to determine potential selenium sources. They have also been concerned with elevated electrical conductivity and boron from the subsurface systems. Upon startup of the Grassland Bypass Project, discharges from systems F51B and F51C were redirected into the Grassland Bypass. Redirection occurred by diverting water directly from the sumps and by

Table 3. Result from Subsurface Agricultural Drainage Survey in the Almond Drain and Rice Drain Areas of the Grassland Watershed: 28 and 29 October 1998

Site	Concentrations			Comments
	EC (µmhos/cm)	B (mg/L)	Se (µg/L)	
28-Oct-98				
F55	—	—	—	A collection sump. The drainage flows east and is piped under the Main Canal where it can be (and is) diverted for irrigated pasture or flows into the Charleston Drain. Not Sampled.
F56	3360	3.9	2.4	Sampled at pipe leaking into drain that runs parallel to the Main Canal on the west side. Sump pump is locked into a PG&E meter system.
F57	2020	1.3	2.9	A collection sump. Flows all drain east to a major outlet ("A"). Sampled some gravity flow into drain.
F57A	—	—	—	Gravity lines north of F57. Could not access.
F61	6200	12	9.1	Sampled from pipe, sump running.
F61B	—	—	—	Gravity lines flowing into Almond Drain just south of Cotton Rd. Could not access.
F62	—	—	—	No access to site due to flooded roadway from irrigation.
Phillips	2320	1.9	2.4	Sampled from pipe, sump running. SW corner of Phillips and Ward Roads. This water likely flows directly into the San Luis Canal, but outlet not visible.
"C"	—	—	—	Apparantly a large area N of Phillips Rd, E of Ward Rd. and south of the SPRR gravity flows into a deep drain that can be pumped directly into the San Luis Canal. No access.
29-Oct-98				
F185	8,620	17	60.2	On-farm management
F50	10,900	42	16.6	To be pumped into San Luis Drain
F50A	—	—	—	To be pumped into San Luis Drain or managed on farm
F50B	13,200	48	10.0	To be pumped into San Luis Drain or managed on farm
F50C	—	—	—	To be pumped into San Luis Drain or managed on farm
F51	4530	6.2	1.0	Discharged to evaporation basin.
F51A	—	—	—	Discharged to evaporation basin.
F51B	—	—	—	Pumped into San Luis Drain.
F51C	—	—	—	Pumped into San Luis Drain
F51D	10,100	33	29.6	To be managed on-farm.

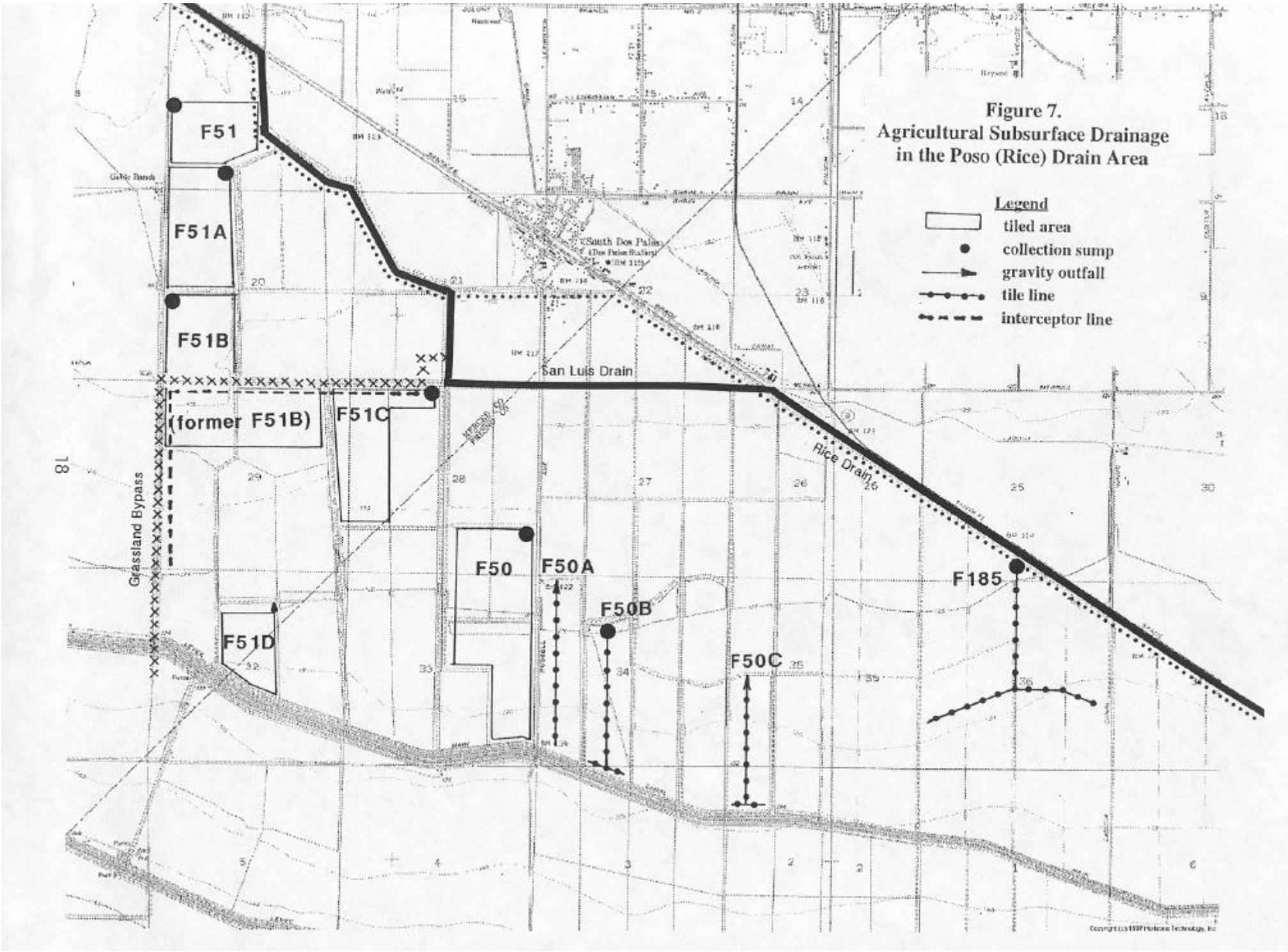


Figure 7.
Agricultural Subsurface Drainage
in the Poso (Rice) Drain Area
Legend
tiled area
collection sump
gravity outfall
tile line
interceptor line
F51
F51A
F51B
(former F51B)
F51C
F51D
F50
F50A
F50B
F50C
F185
San Luis Drain
Rice Drain
Grassland Bypass
South Dos Palos
18

running an interceptor line along the south side of the Bypass channel. Water quality of these two discharges has been monitored monthly by the Grassland Area Farmers. Drainage from system F50 will be redirected into the San Luis Drain before December 1998. Discharges from systems F50A, F50B, and F50C are being evaluated and will either be redirected to the San Luis Drain along the east side of Russell Avenue or will be managed on farm. Discharges from F185 and F51D will be managed on farm to insure that water quality in the Rice Drain meets objectives. Once the redirections proposed are complete, water quality in the Rice Drain will be monitored for electrical conductivity, boron and selenium at two sites: just west of Russell Avenue and further downstream at Mallard Road, to determine the effectiveness of on-farm management practices and potential additional and/or background sources of selenium.

Discharges from F51 and F51A are currently contained in evaporation basins, although the operator is developing a drainage management plan which includes irrigation of halophytes. The plan is currently under review by the Regional Board, Fresno Office. Water quality of the discharge and ponded water in 1997, were 6 µg/L and 8 µg/L selenium, respectively. Selenium concentrations in the discharge during October 1998 were below 2 µg/L. A monitoring and reporting program is being developed for the operator and may include a review of potential seepage from the ponds into the Poso Drain.

On 29 October 1998, water quality samples were collected and analyzed for electrical conductivity, boron and selenium from sites F185, F50B, F50, F51D, and F51. Results and comments are presented in Table 3.

FLOOD WATER

The Grassland Drainage Area is subject to impacts from flooding from westside streams such as Panoche/Silver Creek and to impacts from storms within the drainage area. Panoche Creek and Silver Creek form a watershed that drains more than 190,000 acres of land located west of Interstate Highway 5 and southwest of the DPA (Figure 8). Natural outflow of Silver Creek to the San Joaquin River has been truncated by human activities and the channel now ends abruptly

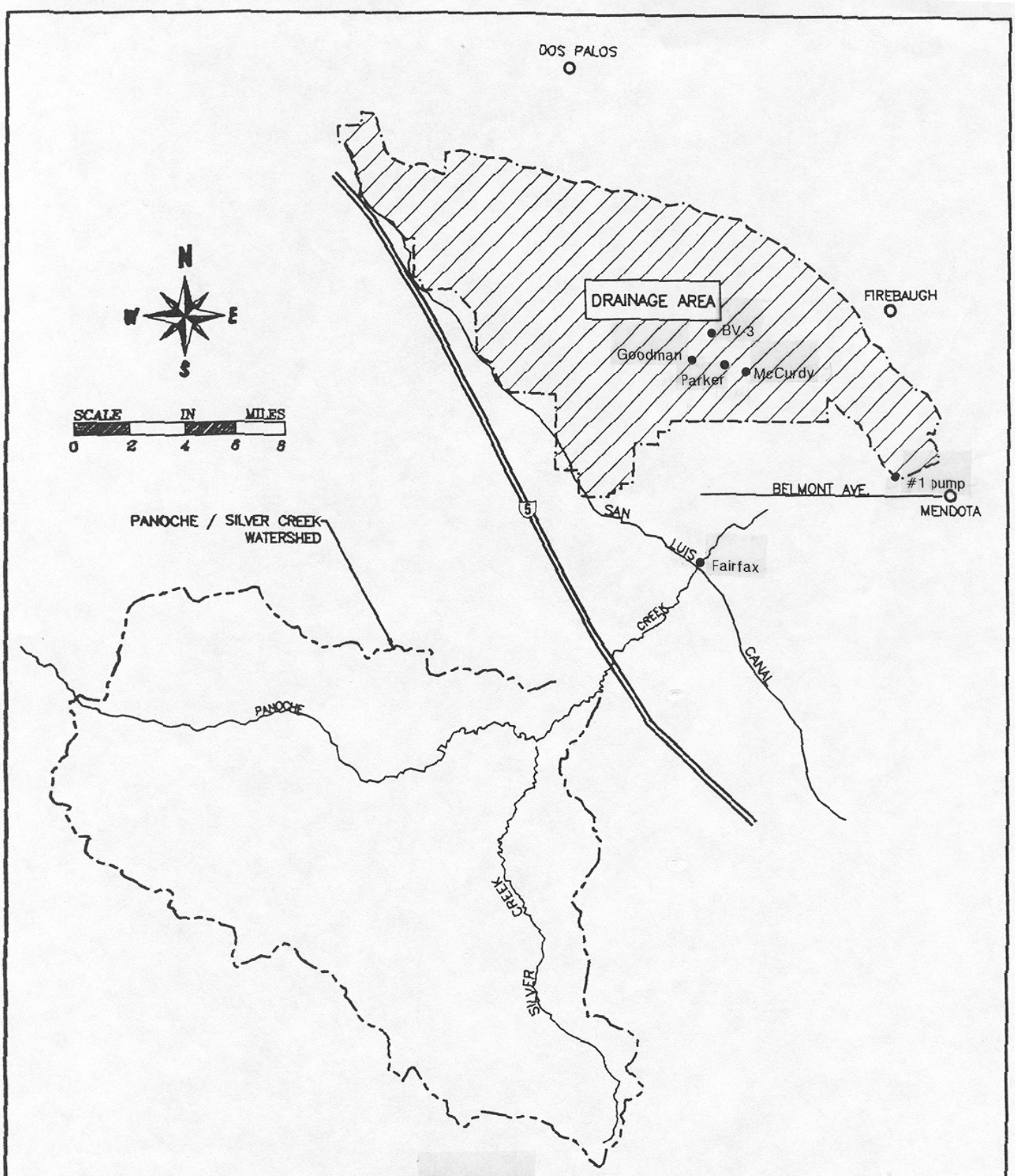


Figure 8

LOCATION MAP
PANOCHE CREEK WATER SHED
AND
GRASSLAND DRAINAGE AREA

● = flood water sampling site for 1998

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APRIL 1997

at the southern edge of the DPA. During some storm events, the instantaneous flow rate in Panoche Creek can exceed 12,000 cubic feet per second, while the average daily flow rate during such events can exceed 2,000 cubic feet per second. These flows can generate more than 40,000 acre-feet of water during a two-week period that includes a storm event (SLDMWA, 1997).

Most storm water from Panoche/Silver Creek is discharged to the San Joaquin River at the Mendota Pool. During some storm events, flow in Silver Creek, which is a dry channel for most of the year, can exceed the capacity of its channel, resulting in extensive flooding of agricultural and residential areas. The channel for Silver Creek actually ends at Belmont Avenue and flood water usually moves eastward from that location toward the City of Mendota and northward toward irrigation and drainage districts in the DPA. This flood water often breaks through canal banks or flows down county roads, accumulating behind bridges or in areas of low elevation, before spilling or being pumped into nearby drainage ditches for discharge through the DPA and Grassland Watershed until final discharge into the San Joaquin River (SLDMWA, 1997 and GAF, 1998). These flood flows may contain elevated levels of selenium as was documented during the February 1998 storm event (Table 4). Impacts of these storm events include: the exceedance of the flow capacity of the Grassland Bypass Project; discharge to historic flood channels with the Grassland Watershed; selenium water quality objective exceedances in wetland water supply channels as drainage and stormwater are rerouted out of the Bypass; potential sediment deposition in the San Luis Drain; and an increase in the total load of selenium leaving the Grassland Watershed.

The Grassland Area Farmers have developed a storm event plan (GAF, 1997) in an attempt to deal with the immediate threat of exceeding the capacity of the Grassland Bypass channel and to track the stormwater and resulting water quality should rerouting of the discharge be necessary. This plan contains the following components:

Table 4. Selenium Concentrations in Flood Water from the Panoche/Silver Creek Watershed: February 1998.

Date	Selenium Concentration (µg/L)					
	Silver Creek @ Fairfax	Silver Creek @ Bypass (#1 Pump)	#3 Goodman to DJ-1	#3 Parker to DJ-1	#3 McCurdy to DJ-1	BV-3 Silver Creek Composite
2/3/98	29	18				150
2/4/98		44				
2/5/98		39				
2/7/98			31	27	29	
2/8/98			30	35	37	
2/9/98			37	37	39	
2/15/98		31	39	39	40	
2/16/98		59	32	39	36	
2/17/98		47	35	35	35	
2/18/98		33	33	34	36	
2/20/98	32					
2/3-4/98						46
2/5-6/98						46
2/7-9/98						42
2/10-12/98						65
2/13-15/98						35
2/16-18/98						41
2/19-21/98						12
2/22-24/98						4
2/25-27/98						83
2/28-3/1						155

Site locations indicated on Figure 8.
Data provided by the Grassland Area Farmers

- Prior notification of discharge to Regional Board personnel, local water and irrigation districts, local State and Federal Wildlife Areas, and the manager of the Exchange Contractors Water Authority;
- Daily notification of continuing discharge;
- Daily monitoring of EC, flow and selenium at Camp 13 Slough and Agatha Canal;
- Controlling the discharge of subsurface drainage sumps by shutting off the sumps and/or cycling their operation

OTHER POTENTIAL SOURCES

Other potential sources of selenium into wetland water supply channels include tail water (surface water) runoff from irrigation and local groundwater seepage. To date, little information is available on these potential sources.

FINDINGS

The primary source of selenium in the Grassland Watershed is from subsurface agricultural drainage in the 97,000 DPA. With the majority of this drainage now rerouted around wetland water supply channels, additional sources of selenium have become apparent. These sources include:

- Supply Water;
- Discharges from the DPA;
- Other areas of subsurface agricultural drainage;
- Storm water and flood flows;
- Tail water runoff; and
- Local groundwater seepage.

To date, most exceedances of the 2 µg/L selenium water quality objective in wetland water supply channels in the Grassland Watershed have been linked to the first four potential sources (supply water, DPA discharges, subsurface agricultural drainage outside of the DPA, and flood flows). A number of the instances of elevated selenium concentrations in the supply water have been linked to discharges from the DPA and storm water flows. Recent efforts have focused on further controlling discharges from the DPA and since all inlets from the DPA to Camp 13 Slough were plugged (by 21 April 1998), selenium concentrations in the slough have only exceeded 2 µg/L on three occasions, with a maximum concentration of 2.6 µg/L. Weekly monitoring is continuing at the site to verify that control measures are effective.

Additional efforts have been made to consolidate and reroute or manage on-farm discharges from subsurface collection systems outside of the DPA. Efforts in the Almond Drive Drain area appear to have reduced selenium concentrations in the San Luis Canal; however, concentrations have continued to slightly exceed 2 µg/L on occasion. Efforts underway in the Poso (Rice) Drain area are being evaluated for effectiveness. Monitoring is being expanded in both areas to help identify selenium sources.

Flood flows are relatively infrequent and sort-term in nature, but have a large impact on selenium concentrations in all the major water bodies in the Grassland Watershed. A storm flow management plan has been adopted by local agencies and is in effect.

Until the major sources of selenium have been controlled, determining impacts from irrigation tailwater and subsurface seepage in addition to general background concentrations will be difficult to evaluate.

FUTURE ACTIVITIES

Although a number of control measures have been put in place since October 1996, selenium concentrations have continued to exceed 2 µg/L in wetland water supply channels in the Grassland Watershed on an infrequent basis. To continue to evaluate the effectiveness of current control measures and guide future efforts, the following activities are anticipated.

- Continue monitoring of CCID Main Canal and other supply water on a regular basis;
- Conduct additional special studies on an as-needed basis;
- Focus on reducing selenium from the following sources:
  --source water;
  --subsurface drainage from outside of the DPA;
- Re-evaluate situation to see if additional work is needed to identify and/or control additional sources.

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